a series; and doubtless the book, which is a novel one, will prove useful alike to professors, assistants, and students. Its primary purpose is that of a laboratory guide.

Four Figure Mathematical Tables. By J. T. BOTTOMLEY. London, Macmillan. 12°.

THIS is a series of mathematical tables comprising logarithmic and trigonometrical tables, and tables of squares, square roots, and reciprocals. In an appendix are contained a number of useful formulas and numbers, especially for those engaged in work in physical laboratories. The book is compiled by a lecturer in natural philosophy in the University of Glasgow.

NOTES AND NEWS.

IN order to expedite the publication of short articles upon astronomical and meteorological subjects which may be prepared at Harvard College Observatory, it has been decided to print them as successive numbers of a series, which will constitute the eighteenth volume of the 'Annals of the Observatory' when a sufficient amount of material has thus been collected. Each number will be published and distributed soon after it has been prepared.

— During this month will appear, under the editorship of Dr. G. H. Rohé, a quarterly journal, *The Climatologist*, devoted to the consideration of questions in the domain of medical and sanitary climatology. As there is at present no other journal in the world exclusively occupying this special field, the editor and publishers believe that there is room for such a publication. Each number will contain forty-eight quarto pages of reading-matter, the subscription price will be fifty cents per year, and the place of publication, S. E. Cor. Baltimore and South Streets, Baltimore, Md.

— Dr. John Vansant of the United States Marine Hospital at St. Louis claims to be the first to have taken photographs by the light of fireflies. He placed twelve fireflies in a three-ounce bottle, covering its mouth with fine white bobinet. The average duration of the flash of each insect was half a second, and the luminous area on the abdomen was about one-eighth of an inch square. The time of exposure was fifty flashes.

— Lieut. J. F. Moser, U.S.N., commanding the Coast Survey steamer 'Bache,' has just submitted a report of the hydrographic work executed by that steamer from Cedar Keys southward to a point off Chasahowitzka River, and the finishing of the hydrography from Cape Romano to the delta of the Mississippi. He refers to the great difficulty of running triangulations, owing mainly to the obscurity or entire absence of former triangulations, or other ear-marks of the locality to be surveyed. St. Martin's Reef was found to continue as far north as Homosassa, thence trending eastward to join the shallow waters of Crystal River. It is on the Florida banks, of which St. Martin's Reef forms an inshore part, that many of the commercial sponges are taken, and a large number of vessels are yearly engaged on the work. The tides in this locality were found to be easily affected by winds, causing great irregularity in their range, stand, and times of movement. The coast was found to be low and rocky, and the entire bottom covered with porous rock. The anchorage off St. Martin's Reef is good and safe in any weather except a hurricane. Lieutenant Moser says the country is dreary, desolate, and uninhabited, and the coast-line consists of fringing islands, thickly covered with mangrove. On these islands oysters are found growing in trees, the spawn having attached themselves to the branches at high water and developed into oysters. Bird-life was not abundant, even sea-gulls being conspicuous by their absence. Rail and blue and white herons were found, but even these birds have been driven away by the plume-hunters.

— A. Auwers has thoroughly discussed the alleged periodical changes of the diameter of the sun, and finds that in fact they do not exist. His researches, which are founded on 19 series of observations, — 12 of which refer to the horizontal diameter, and comprise 21,000 observations, while 7 refer to the vertical diameter, — show that the periodical changes are due to the influence of the temperature upon the instruments with which the observations were made, and that for this reason the period corresponds to that of the annual period of temperature.

LETTERS TO THE EDITOR.

Experimental Physics for Schools.

FOR years one of the requirements for admission to Harvard College has been such knowledge of physics as may be obtained from the study of any one of certain well-known elementary text-books. To this requirement is now added the study of a certain astronomical text-book, but as an alternative to both the text-book physics and the astronomy there is recommended a course of study in physics involving considerable laboratory work on the part of the pupil, supplemented by instructions from a text-book or a course of lectures.

Two questions suggest themselves to the teacher of physics when he finds himself met by the proposition to give laboratory practice to a whole class: 1st. Is this desirable if practicable? 2d. Is it practicable?

Without undertaking to discuss at large the theory of a liberal education, we can note a few considerations which will enable us to answer the first of these questions with some confidence: 1st. Physics is studied partly for training and partly for information. 2d. Text-book physics alone gives but little training that cannot be given by arithmetic, algebra, and geometry, all of which studies are pursued by the pupil before he enters college. 3d. Physics as taught by the laboratory experience of the pupil gives a kind of training that is not given by any course of study *required* for admission to Harvard College or, perhaps, any other college in the country. This training is partly of the senses and partly mental. It is true that many book-studies educate the senses to a certain extent, and the logical faculties, but unfortunately it is possible for a person who is observing and logical in things which he is in the habit of studying to be quite the opposite in dealing with things which do not habitually occupy his mind. Now, laboratory physics is the only elementary study for admission to Harvard College that requires the student to look beyond the pages of a book, and although most students do look at other things than books, they are not in the habit of *studying* things outside of books. 4th. The information given by the text-book alone is wide but superficial and vague. It is like that knowledge of a country which one may get by travelling rapidly over it on a railroad train. 5th. The information given by laboratory practice alone is definite but narrow. It is like that knowledge of a country which one would get if he tried to go over the whole of it on foot. 6th. Most students show far more interest in laboratory work than in the study of a text-book, even when the same subjects are dealt with in both cases. Much of the repugnance which many students feel for physics as they study it comes from the almost painful effort of the imagination to body forth the things described in the text-books, and which might be seen directly and handled in the laboratory.

From these considerations we reach the conclusion that the course which Harvard recommends to preparatory schools is desirable, if practicable, viz., to have the pupil study intimately certain topics by the laboratory method, and to enlarge upon, apply, and connect the knowledge so gained, by means of a text-book or a course of lectures. In the opinion of the writer, a course of lectures sufficiently extensive and systematic to take the place of a text-book for this purpose is beyond the present powers of most preparatory schools.

It may be hoped that by following such a course in physics the student will escape, on the one hand, a condition of blind and helpless dependence upon text-books, and, upon the other hand, the scarcely less unfortunate state of self-sufficiency which cannot or will not profit by the literature of the science.

Harvard University has issued for the use of teachers engaged in preparing students for its college classes a pamphlet giving a list of forty laboratory exercises, with specifications of the apparatus and materials to be used in these exercises, and with directions for their performance, or references to manuals giving such directions. These exercises are to be performed by the pupil. To speak cursorily, they deal with certain distinctive characteristics of the solid, liquid, and gaseous states of matter, the determination of specific gravities, the first principles of statics and dynamics, evaporation and boiling, the determination of the fixed points of a thermometer, expansion of solids and gases, specific heat, latent heat, velocity of sound, interference of

sound-waves, photometry, plane mirrors, converging lenses, lines of magnetic force, construction of galvanic cells, action of electrical currents upon magnets, electrical resistance of wires, battery resistance, construction of electro-magnets. Nearly all of these exercises are of a quantitative character, requiring measurements of some kind. It is expected that they will be liberally supplemented with other less formal experiments, not necessarily to be performed by the student, such as are described in ordinary text-books, with problems, and with general teaching, all of such a range and character as to give effect and continuity to the course.

In considering whether such a course of physics is practicable there are several points to be looked at: —

1st. The material equipment required. It will not in general be practicable for a teacher to give proper attention to more than twelve students working in the laboratory at the same time. The cost of the *portable* apparatus and material needed to enable twelve students to follow the course marked out in this pamphlet, each working upon the same experiment at the same time but in general independently, may be any thing from $250 to $450, according to the amount of time and skill the teacher can devote to its preparation. I think this part of the equipment, with apparatus ready made, can be bought outright for the larger sum mentioned. There will be needed also two strong tables, each about twelve feet long and three feet wide, one or two sinks with water-faucets, and for each student a supply of gas for a Bunsen burner.

For a school already well supplied with the ordinary *illustrative* apparatus, the total cost of adding the material equipment for the laboratory course, on the scale supposed, may range from $400 to $800. If only one or two students are to be provided for, the cost may be not more than $50 or $100.

2d. The demand upon the pupil's time. In the summer of 1886, Harvard sent out to a large number of teachers of physics in preparatory schools a circular requesting answers to certain questions, one of which related to the amount of time devoted to this study in their respective schools. About eighty replies to this circular were received, and the conclusion from these replies was, that, in laying out the elementary physics courses for admission to the college, we might assume that the pupil would have for this subject the equivalent of one school exercise of about forty-five minutes daily for one school-year of thirty-five or forty weeks, with some hours of study weekly out of the school-room. The proposed course has been planned in accordance with this estimate. This is probably about as much time as will be required for elementary French or elementary German in fitting for Harvard, and not more than one-half as much as most candidates have given to prescribed Greek, or one-third as much as they have given to prescribed Latin.

3d. The arrangement of hours. Experience in the Harvard physical laboratory, with a course very similar to the one proposed for the schools, dictates the suggestions, 1, that one school-hour per week be given to a preliminary explanation, and perhaps hasty performance by the teacher, of the exercises presently to be undertaken by the pupils, the whole class being assembled for this exercise; 2, that each pupil have two consecutive school-hours per week for the actual performance of the formal experiments of the course, the class, if large, being divided for this purpose into sections of not more than twelve; 3, that the other two school-hours per week be devoted to the supplementary work of the course with the whole class assembled. In order that the time alloted for the laboratory work may be sufficient, the student should be required to plan his work and his note-taking, so far as this is practicable, before coming to the laboratory.

4th. The demand upon the teacher's time. Scholars so young as those will be who may take this course need much direction in their laboratory work. The teacher should be in the laboratory whenever work is going on there. The preparation and care of apparatus and the proper supervision of the students' note-books will take much time, especially at first. After every thing has settled into regular working order, it may require six or eight hours more, weekly, of the teacher's time to conduct a class of thirty or forty students in the experimental laboratory course than to conduct a class of the same size in the text-book course, which is to be the alternative.

5th. The fitness of teachers for such work. Probably only a small proportion of the teachers of physics in the preparatory schools have had such a training as would enable them to arrange and conduct the proposed course without considerable effort and some mistakes. For the first year or two crude work is to be expected, but teachers who are possessed of some mechanical skill, a good general knowledge of physics, considerable energy, and a willingness to think, will quickly become accustomed to the duties of the new course.

Just how great the difficulties which have here been touched upon will appear to the preparatory schools the writer is unable to foresee, but there can be little doubt that the larger schools which send boys to Harvard will, in general, speedily adopt the experiment method in preparing boys in physics. Last July about eighty candidates presented themselves for the entrance examination in the experiment course, and, although this course as now laid out will be more severe than that which some schools have followed during the past year, it is unlikely that any school having once undertaken the experiment course will abandon it for the text-book alternative.

The enthusiasm with which many teachers welcome the opportunity to follow the experiment method is very striking, and encourages the hope that the day of perfunctory cramming in physics merely for the purpose of getting into college is nearly over.

E. H. HALL.

Romantic Love and Personal Beauty.

THE above subject in its varied aspects, to which the review of Mr. Finck's book in *Science* has called attention, must be regarded by all thoughtful men, and above all by the biologist, as one of great, possibly unsurpassed interest to mankind. The question in its broadest aspect comes to this: How are the interests of mankind dependent on conjugal mating and the circumstances under which this is brought about? As no one can pretend to see the whole truth on such a subject (or indeed any other of comprehensive range), I shall give the results of my own observations and reflections, with a view of drawing increased attention to a subject of such transcendent importance. While every one, in some vague way, recognizes the importance of the step taken when two human beings agree to join their fortunes for life, the multiform implications of such an act require for their comprehension a biological knowledge that but few, in the present state of civilization, possess.

Mr. Finck, after enumerating the characteristics of romantic love, grants that many of these are found in the lower animals, but at the same time leads us to believe that romantic love is wholly a modern growth, or that it had no genuine existence, at all events, previously. Is this position consistent for an evolutionist? If it existed lower in the scale than man, it seems very unlikely that it should cease to exist in the higher form. Mr. Finck seems to have rather overstated the case. That it never had complete development till modern times, that it was smothered, dwarfed, or perverted, we will freely admit; but we must deny that it is purely a *new* thing. Why is it, as we know it, modern in its development? Because never before was the altruistic conception of human conduct fully developed. That a man should sacrifice himself for an inferior was utterly opposed to all ancient ideas. When this conception took shape it at once began to appear that woman, being the weaker physically at least, demanded, in harmony with the altruistic principle, the service and sacrifice of the stronger, hence gallantry, etc. Formerly this was but an undeveloped germ in the breast of man; but it was there, however, and is not an absolutely new thing. In a word, romantic love demands a relatively high moral development for its vigorous growth. Perhaps Mr. Finck would really contend for no more than this.

Darwin, consistently with the great influence he assigned to sexual selection in his scheme of organic evolution, included man with other animals. He pointed out that "the men who are rich through primogeniture are able to select, generation after generation, the more beautiful and charming women; and these [he adds] must generally be healthy in body and active in mind." No doubt this explains a great deal, but it does not explain the origin of beauty in man or woman. In explaining the high average of comeliness and the relative frequency of beauty in human beings in America, this factor enters very largely into the explanation both of the preservation and increase of beauty of form and expression,